**Claims**

1. An optical waveguide structure comprising a core layer having a first refractive index $n_{core}$, an array of sub-regions within the core having a second refractive index $n_{rods}$, the array of sub-regions extending longitudinally along the waveguide and giving rise to a photonic band structure experienced by an optical mode travelling through the waveguide structure, and a cladding layer adjacent to the core layer having a refractive index $n_{cladding}$, wherein:

$$n_{core} > n_{rods} \geq n_{cladding} \text{ and } n_{core} - n_{rods} > 0.1.$$

2. An optical waveguide structure according to claim 1, wherein the array of sub-regions gives rise to a photonic bandgap.

3. An optical waveguide structure according to claim 1, wherein the waveguide structure is a planar waveguide structure further including a buffer layer having a refractive index $n_{buffer}$, wherein the core layer is positioned between the buffer layer and the cladding layer and wherein:

$$n_{core} > n_{rods} \geq n_{buffer}.$$

4. An optical waveguide structure according to claim 1, wherein the waveguide structure is an optical fibre structure, the cladding layer surrounding the core layer.

5. An optical waveguide structure according to claim 1, wherein the core layer has a refractive index between 1.4 and 4.

6. An optical waveguide structure according to claim 1, wherein the sub-regions have a refractive index between 1.3 and 1.6.

7. An optical waveguide structure according to claim 1, wherein the cladding layer has a refractive index between 1.3 and 1.6.

8. An optical waveguide structure according to claim 3, wherein the buffer layer has a refractive index between 1.3 and 1.6.

9. An optical waveguide structure according to claim 1, wherein the sub-regions are formed from silicon oxynitride or silicon dioxide.

10. An optical waveguide structure according to claim 1, wherein the core layer is formed from silicon nitride, doped silica, tantalum pentoxide or doped tantalum pentoxide.

11. An optical waveguide structure according to claim 1, wherein the cladding layer is formed from silicon dioxide.

~~12. An optical waveguide structure according to claim 3, wherein the buffer layer~~ is formed from silicon dioxide.

13. An optical waveguide structure according to claim 1, wherein the sub-regions extend through the cladding layer as well as the core layer.

14. An optical waveguide structure according to claim 3, wherein the sub-regions extend partially or fully into the buffer layer.

15. An optical waveguide structure according to claim 1, wherein the cladding layer includes sub-regions corresponding to the sub-regions in the core layer having a refractive index which is greater than or equal to the refractive index of the cladding layer but which is less than or equal to the refractive index of the sub-regions in the core.

16. An optical waveguide structure according to claim 1, wherein the core layer includes a lateral waveguiding region having no sub-regions.

17. An optical waveguide structure according to claim 16, wherein the waveguiding region includes a waveguide bend.

18. An optical device including an optical waveguide structure according to claim 1.

19. A method of manufacturing a optical waveguide structure comprising the steps of:

providing a core layer having a first refractive index $n_{core}$;

providing an array of sub-regions within the core having a second refractive index $n_{rods}$, the array of sub-regions extending longitudinally along the waveguide and giving rise to a photonic band structure experienced by an optical mode travelling through the waveguide structure; and

providing a cladding layer adjacent to the core layer having a refractive index $n_{cladding}$; wherein:

$$n_{core} > n_{rods} \geq n_{cladding} \text{ and } n_{core}-n_{rods} > 0.1.$$

20. A method according to claim 19, wherein the optical waveguide is planar, the method further including the step of providing a buffer layer having a refractive index $n_{buffer}$ on the opposite side of the core layer to the cladding layer, wherein:

$$n_{core}>n_{rods}\geq n_{buffer}.$$

21. A method according to claim 19, wherein the optical waveguide is an optical fibre, the method further including the steps of:

providing the cladding layer surrounding the core layer.

22. A method of guiding an optical signal comprises the step of passing an optical signal through a waveguiding region of an optical waveguide structure comprising a core layer having a first refractive index $n_{core}$, an array of sub-regions within the core layer having a second refractive index $n_{rods}$, the array of sub-regions extending longitudinally along the waveguide and giving rise to a photonic band structure experienced by an optical mode travelling through the waveguide structure, and a cladding layer adjacent the core layer having a refractive index $n_{cladding}$, wherein:

$$n_{core}>n_{rods}\geq n_{cladding} \text{ and } n_{core}-n_{rods} > 0.1.$$

23. A method according to claim 22, wherein the optical waveguide structure is a planar structure, further including a buffer layer having a refractive index $n_{buffer}$, wherein the core layer is positioned between the buffer layer and the cladding layer and wherein:

$$n_{core}>n_{rods}\geq n_{buffer}.$$

24. A method according to claim 22, wherein the waveguide structure is an optical fibre structure, wherein the cladding layer surrounds the core layer.

25. An optical waveguide structure comprising a core layer having a first refractive index $n_{core}$, and a 2-dimensional array of sub-regions within the core layer having a second refractive index $n_{rods}$, the array of sub-regions extending longitudinally along the waveguide and giving rise to a photonic band structure within the core layer, and a cladding layer adjacent the core layer having a refractive index $n_{cladding}$ wherein:

$$n_{core} > n_{rods} \geq n_{cladding}.$$

~~26. An optical waveguide structure according to claim 25, wherein $n_{core}$ - $n_{rods}$ > 0.1.~~

27. An optical waveguide structure according to claim 25 or 26, wherein the waveguide structure is a planar waveguide structure, the core layer being formed between the cladding layer and a buffer layer, the buffer layer having a fourth refractive index $n_{buffer}$, wherein:

$$n_{core} > n_{rods} \geq n_{cladding} \text{ and } n_{buffer}.$$

28. An optical waveguide structure according to any one of claims 25-26, wherein the waveguide structure is an optical fibre, the cladding layer having surrounding the core layer.

29. A method of manufacturing a optical waveguide structure comprising the steps of:

providing a core layer having a first refractive index $n_{core}$;

providing a cladding layer adjacent to the core layer having a refractive index $n_{cladding}$;

forming a 2-dimensional array of holes in the core layer extending longitudinally along the waveguide structure;

filling the holes with a material having a second refractive index $n_{rods}$, wherein:

$$n_{core} > n_{rods} \geq n_{cladding}$$

30. A method according to claim 29, wherein $n_{core} - n_{rods} > 0.1$.

31. A method according to claim 29 or 30, wherein the optical waveguide is a planar waveguide, the method further including the steps of:

providing a buffer layer having a refractive index $n_{buffer}$ on the other side of the core layer to the cladding layer; wherein:

$$n_{core} > n_{rods} \geq n_{cladding} \text{ and } n_{buffer}.$$

32. A method according to any one of claims 29-31, wherein the optical waveguide is an optical fibre, the method including the step of:

providing the cladding layer surrounding the core layer.

33. A method of guiding an optical signal comprising the step of passing an optical signal through a waveguiding region of an optical waveguide structure comprising a core layer having a first refractive index $n_{core}$, a 2-dimensional array of sub-regions within the core layer extending longitudinally along the waveguide having a second refractive index $n_{rods}$, the array of sub-regions giving rise to a photonic band structure within the core layer, and a cladding layer adjacent to the core layer having a refractive index $n_{cladding}$, wherein:

$$n_{core} > n_{rods} \geq n_{cladding}.$$

34. A method according to claim 33 wherein $n_{core} - n_{rods} > 0.1$.

35. A method according to claim 33 or 34, wherein the waveguide is a planar waveguide, wherein the core layer is formed between the cladding layer and a buffer layer, the buffer layer having a fourth refractive index $n_{buffer}$, and wherein:

$$n_{core} > n_{rods} \geq n_{cladding} \text{ and } n_{buffer}.$$

36. A method according to any one of claims 33-35, wherein the optical waveguide is an optical fibre, wherein the cladding layer surrounds the core layer.